

THE EVOLUTION OF ONLINE LEARNING IN BRIDGING MATHEMATICS AT A DISTANCE: THE TENSION BETWEEN LEARNING NEEDS, TECHNOLOGICAL INNOVATION AND ACCESS RESTRICTIONS IN AN AUSTRALIAN REGIONAL UNIVERSITY.

Janet A Taylor

*Office of Preparatory and Academic Support
The University of Southern Queensland Australia.*

The learning needs of students in bridging mathematics programs offered by distance education are well known. This paper examines the evolution of online initiatives designed to meet the needs of on and off campus students at a large Australian regional university. The developments, including specific support programs for pre-tertiary, engineering, statistics, economics and overseas students as well as generic mathematics support for all students, range from document delivery systems to interactive multimedia and online discussion groups. These are discussed within the context of online learning theory and the tension between delivery innovation and access restrictions.

In the twenty-first century universities are faced by two great challenges, student diversity and the new technologies. There is little doubt that few universities have escaped the influences and pressures on higher education produced by the move from elite to mass higher education. In just close to three decades, there has been a substantial increase in numbers of students accessing university education and a substantial change in the student profile of those entering universities. This changing student diversity has placed increasing pressures on the university sector to find ways to address the learning needs of students in an equitable manner. As early as 1983 Keimig reports on a hierarchy of effective retention programs in which the most successful are ones that are integrated into faculty structures and teaching. Richardson and Skinner (1991) and Kleeman (1994) report similar findings in ethnically diverse higher education populations.

The other challenge is that of the rapidity of change imposed by the development of the new technologies.

Over the past twenty years, the transformation of a relatively simple computer network used by a few researchers into a global Internet, involving hundreds of millions of people and generating a new economic order, took government, business and education, by surprise. (Taylor, J.C 2001)

This paper focuses, through the eyes of bridging mathematics, on the intersection of two major changes taking place within higher education in the 21 century: the continuing struggle to manage student diversity and the pressures and challenges imposed by the introduction of the new technologies in teaching and learning.

The learning needs of students

The University of Southern Queensland (USQ) is a large regional Australian university, which offers courses across 5 faculties in on-campus, distance education and online modes. It currently enrolls approximately 20 000 students, 75% of whom study off campus from every state in Australia and overseas. Each year within the area of bridging

mathematics at USQ 2000-3000 undergraduate students access a range of mathematics learning support programs offered through the Office of Preparatory and Academic Support, 60 students enroll in an on-campus preparatory program for overseas students (UNIPREP) and approximately 1000 students enroll in the Tertiary Preparation Program (TPP), which offers five levels of mathematics entirely at a distance. The majority of students within TPP are scholarship students from equity groups defined by DEST Australia to be people from socio-economically disadvantaged backgrounds, from rural and isolated areas, with disabilities, and from non-English speaking backgrounds, women (especially women in non-traditional areas of study); and Indigenous Australians. The remainder of students are fee paying and belong to non-equity groups.

In most instances within the bridging mathematics community such programs are designed within a constructivist philosophy of learning aiming to shift learners from passive to active roles and from de-contextualised tasks to authentic experiences. This focus on the learner means the majority of programs are based on a developmental model of learning rather than a deficit model. In pragmatic terms, bridging mathematic curricula and/or practitioners for distance education are required to provide their students with:

- a set of materials which allows them to refresh or develop their mathematical skills at their own pace;
- a mechanism whereby they can self assess their mathematical readiness;
- a clear pathway through which they can get advice if they felt they were not ready or otherwise;
- clear alternatives available if they find they are not prepared;
- personal support throughout the support period, and later if necessary;
- consideration for the independence and maturity exhibited by distance education students;
- structures whereby they can work with fellow students in group situations.

Yet within the online arena Postle and Sturman (2000) indicate that three models of student learning form the essence of well-designed and well-developed programs. These models have been outlined by Miller and Miller (1999), Gunawardena and Zittle (1996) and Paulsen (1995) and Taylor, Postle, Reushle and McDonald (2000) and are as follows.

Independent Learner

The “independent learner” model is referred to as the “Content-Learner” interaction (Miller & Miller, 1999) or the “one alone” learner (Paulsen, 1995). Gunawardena and Zittle (1996 p 54) indicate that this model represents “the process of intellectually interacting in the content that results in changes in the learner’s understanding, perspective or the cognitive structures of the learner’s mind”.

Interactive Learner

The “interactive learner” model is referred to as the one-to-one or one-to-many model (Paulsen, 1995). It has been typified by teacher/learner interactions, which drive the learning experience.

Collaborative Learner

The “collaborative learner” model is referred to as the many-to-many experience (Paulsen, 1995) and acknowledges the importance of shared development of knowledge through collective learning. With the focus moving from the instructors to the students as who share information and resources.

Technological Innovation

For some years around the world distance education and open learning specialists have been encouraged by the increasingly diverse and dispersed student population to take up the new technologies. Over this time a range of technologies have been utilized. Taylor (1995, 2001) provides a framework for understanding the rationale behind the expansion of teaching strategies available through distance education initiatives, particularly those involving technology and details 5 generations of distance education technological development starting with print in the 1st generation and finishing with computer mediated communication, using automated response systems in the 5th. The 1st to 3rd generation models can be labeled as the “independent learner” model, while the 4th and 5th target the “interactive” and “collaborative” learners. Currently, USQ has programs, which utilize the first 4 generations, with plans to move into 5th generation in the near future.

Access Restrictions

Even though costs of hardware, software and connection fees have reduced significantly over the past 5 years, the levels of access to some groups of students are still low. At USQ, all on campus students have full access to the Internet via computer laboratories and/or wireless network technology, while distance education students must provide their own hardware, software (specialized software is provided in some courses) and access to the Internet. Using provision of email addresses as an indicator of access to Internet facilities, it is apparent that students enrolled in the preparatory programs (TPP) at USQ are less likely to have access to the internet than first year external undergraduate students (Table 1). This is even more pronounced in students from equity groups who, when compared with non-equity TPP students and all other external student groups investigated, have email access levels stable at approximately 30% over the past 5 years. All other groups, including non-equity TPP students have risen by approximately 30 percentage points over the same time period.

Table 1: Percentage of distance education students in each course who have email access.

	1995	1997	1998	1999	2000	2001	2002
TPP							
Equity Groups	7*	15*	30	26	31	35	32
Non-equity Groups	23*	34*	40	40	52	60	71
Undergraduate							
Mathematics	-	-	53	-	-	-	83
Statistics	-	-	60	-	-	-	88
Economics	-	-	68	-	-	-	86
Engineering Computing	-	-	61	-	-	-	85

* These data are based on survey results of students who declare they have email access and are reported in Bull and Maughan (1995) and Van Vuuren and Bull (1997).

In 2002 this email access pattern is reflected within each of the TPP mathematics courses. The lowest level of mathematics is Level A, which prepares students for nursing, psychology and education, and enrolls 38% of students possessing email access, followed 54% in Level B (business) and 67% in Levels C and D (science and engineering). Level A mathematics routinely enrolls 300-400 students each semester and has the highest number of equity scholarship students (76%) compared with the other levels of mathematics (44-56%).

Online support programs at USQ from 1995 – 2002

Online support initiatives for bridging mathematics are defined in this paper to be those which prepare students for university (e.g. TPP) and those which support undergraduate students. Such initiatives can be classified using the learner framework previously described (Table 2). Although the TPP has been extremely successful as a traditional distance education program (Clarke and Bull, 1998), the most successful online initiatives have occurred within those provided for undergraduate students. These developments commenced in 1995 with the development of Self Test (Taylor, 1998) and associated resources for Bachelor on Engineering students. This program provided students with the Self Test package, suite of mathematical topics in downloadable form, a series of online synchronous tutorials and access to one-to-one support via email or phone. This model of support has proven to be successful with commencing undergraduates and is now offered within economics (1999) and statistics (1999) courses and is planned for nursing students in 2003. The programs are designed to support the independent learner with opportunities for interaction occurring only within the online tutorials. In semester 1 of 2002, 1200 students were offered these programs. The technology used has components of 1st to 4th generation distance education technologies (Taylor 2001).

Other resources are offered by The Learning Centre, which has provided online one-to-one consultations at a rate of 60 per semester for the past 4 years. It also provides online resources e.g. downloadable “How to use” a calculator booklets. All these resources are brought together in a new initiative (released March 2002) entitled *ALS online* (Academic Learning Support Online). This is a fully online resource with modules on ‘Getting started’, ‘Effective Study’, ‘Communication Skills’, ‘Mathematics Skills’ and ‘Assessments’. Within the mathematical skills section the following topics are included: coping with mathematics anxiety; mathematics exam skills; how to study mathematics at a distance; how to use a calculator; mathematics within a course; and mathematics topics.

Table 2: USQ online initiatives with respect to the three model of online learning.

Independent Learners Model	
Undergraduate support	Preparatory Programs
<ul style="list-style-type: none"> • Engineering Support 1995, Statistics Support 1999, Economics Support 2000 <ul style="list-style-type: none"> ○ Self assessment programs ○ Study materials • Communication for Academic Purposes, including mathematical components since 2001. 50 hour online resource based course designed to orient students, especially overseas students, to study at USQ. • <i>ALS Online</i> series of online resources for all undergraduates includes mathematics topics and mathematical study skills, 2002 • Foundation Mathematics 2002, Course based support web site of resources The Learning Centre Resources e.g. online calculator booklets 1999 	<ul style="list-style-type: none"> • Tertiary Preparation Program mathematics, offers course based web site of resources since 1999 • UNIPREP, course based web site of resources for on campus overseas students since 2002
Interactive Learners Model	
Undergraduate Programs	Preparatory Programs
<ul style="list-style-type: none"> • The Learning Centre – online drop-in support via email since 1999 • Engineering Support – online drop in support via email since 1995 • Engineering (1995), Statistics (1999) and Economics (1999) support – online synchronous tutorials since 1995 • Foundation Mathematics <ul style="list-style-type: none"> ○ Synchronous online tutorials in Foundation Mathematics since 1997 ○ Computer Managed Assessment since 1996 ○ Informal asynchronous discussion groups since 1998 	<ul style="list-style-type: none"> • Tertiary Preparation Program <ul style="list-style-type: none"> ○ 2 levels of mathematics offer online synchronous tutorials since 1998 ○ Asynchronous discussion groups offered in all levels since 1998 ○ Email consultation since 1999
Collaborative Learners Model	
Undergraduate Support	Preparatory Programs
<ul style="list-style-type: none"> • Foundation Mathematics, asynchronous problem based discussion groups since 2002 	<ul style="list-style-type: none"> • Asynchronous discussion groups offered in all levels since 1998 have not successfully developed collaborative learning

The most developed undergraduate support initiative is Foundation Mathematics an integrated curriculum project shared between OPACS and the Department of Mathematics and Computing. The course enrolls at most 800 students (400 external students) in 1st semester of each year. In 2002 it provided students with online resources via the course web site, 4 synchronous online tutorials each semester, computer managed assessment for weekly formative quiz tasks and asynchronous discussion groups. To date this is the only initiative within USQ's mathematics support initiatives that has successfully included components of all three learner models (the Independent, Interactive and Collaborative). The collaborative component is achieved only in the asynchronous online discussion groups in which groups of 30 students are allocated to a tutor whose role is to facilitate discussion and answer mathematical questions as needed. Each week the facilitator introduces a workshop topic for discussion. To date (6th week of a 15 week semester) postings per group range from 65 to 165 and are typified by students presenting possible solutions to the problem, asking questions about assumptions and commenting on alternative solutions. The discussion is opened each week by the tutor with an announcement, but is generated by the students with the tutor participating as necessary to assist in summarizing conclusions.

Online initiatives within the Tertiary Preparation Program have not been as successful as those offered to undergraduate students. Although in the survey conducted by Van Vuuren and Bull (1997), over 90% students indicated that they would study via the Internet if possible, few use or are able to use Internet resources when offered. For example, Level B Mathematics is offered each semester to students preparing to study business at an undergraduate level. It routinely enrolls 70 students each semester with 54% of students possessing email addresses and 55% coming from equity groups. When the levels of participation are compared with those found in a first year undergraduate mathematics course (Table 3), results are very low in the areas of one-to-one consultations via email and asynchronous discussion groups.

Table 3: Comparison between student participation in online activities in first year mathematics and TPP level B Mathematics.

Type of online activity	TPP Course*	Undergraduate course *
Online resources	-	-
Synchronous online tutorials	0.07	0.05
Asynchronous online discussions	0.07	2.1
Email consultations, one-to-one	0.11	1.45

*Level of participation is corrected for number of students enrolled in the course by dividing the total number of participants/postings/emails by the number of external students enrolled.

Discussion

The mathematical and learning needs of students in or preparing to enter higher education have been voiced many times within the Bridging Mathematics community. With the advent of the new technologies, new initiatives have proliferated especially at USQ where the necessity to support distance education students is paramount. Yet few programs have been able to follow standards for online course development which prescribe that

courses should have components that address the needs of independent, interactive and collaborative learners. The paucity of online support initiatives containing components which extend to interactive and collaborative learning lies in the curriculum design of the programs. In most instances, the online support initiatives for undergraduates are add-ons to first year courses and are not fully integrated into the learning program. This means that the programs focus on the resource needs of the students and rely on the individual student to take the initiative to participate. Over 80% of the developments for undergraduates at USQ support independent learners in this way. It is only in the fully integrated curriculum development represented by Foundation Mathematics that the interactive and/or collaborative learning models have been developed. Access restrictions are not apparent within the external undergraduate cohort and it is anticipated that online support will continue to evolve. The prediction made by Keimig in 1983 for general support programs applies equally well to online support initiatives in 2002, that is, the more integrated into the curriculum the initiative, the more effective it will be.

The provision of online activities within preparatory programs, however, presents a very different situation. Although online initiatives have been repeatedly attempted over a number years none have been successful. The levels of access to technology are lower in these students than in undergraduates, and even though non-equity students have had increasing levels of access over the past 4 years, equity students have consistently low levels. The presence of large proportions of equity students, particularly within the lower levels of mathematics, means that access restrictions are extreme and course designers must be cautious about further excluding students who already have a history of exclusion from educational opportunities.

The experience at USQ indicates that the tension between learning needs, technological innovation and access restrictions for undergraduates pulls in the direction of learning needs as programs attempt to cater for independent, interactive and collaborative learners. While with preparatory students the focus is still on access restrictions, especially for students from the equity groups. In both cases further evolution must be slow and careful.

References

- Bull, D. and Maughan, D. (1995). Information Technology Availability and Proficiency: Summary Of Finding and Survey Results Of The Tertiary Preparation Program 1995. Office of Preparatory and Academic Support, University of Southern Queensland, Australia. 18 pp.
- Clarke, J., & Bull, D. (1998, October). The importance of enabling programs in providing higher education opportunities for the educationally disadvantaged. *Proceedings, 3rd National Equity and Access Conference*, Yeppoon, Queensland.
- Gunawardena, C.N. and Zittle, R.(1996). An examination of teaching and learning processes in distance education and implications for designing instruction, in Beaudoin, M.F. (ed.) *Distance Education Symposium 3: Instruction, ACSDE Research Monograph*, no 12, pp.51-63.
- Kleemann, G.L. (1994) Achieving academic success with ethnically diverse students: Implications for student affairs. *NASPA Journal* 31(2),137-149.

- Keimig, R. (1983) Raising academic standard: a guide to learning improvement. ASHE-ERIC/Higher Education Research Report No 4.
- Miller, S.M. and Miller, K.L.(1999) 'Using instructional theory to facilitate communication in web-based courses', *Educational Technology & Society*, 2(3) [Online] URL http://ifets.ieee.org/periodical/vol_3_99/miller.html Accessed 24 November 1999.
- Paulsen, M.F.(1995) *The Online Report on Pedagogical Techniques for Computer-Mediated Communication*, <http://www.hs.nki.no/~morten/cmcped.htm>
- Postle, G, Taylor, J C, Taylor, J A and Clark, J (2000). Flexible Delivery and Inclusivity: Pedagogical and Logistical Perspectives. in *Changing the Culture of the Campus: Towards an Inclusive Higher Education* (Eds Thomas, L. and Cooper, M.) Staffordshire University Press, UK. p 127- 141.
- Postle, G. and Sturman, A, (2000). Models of learning as a factor in online education: an Australian case study. Society for Research in Higher Education Conference, Stirling. UK 2000.
- Richardson, R. C. and Skinner, E. F. (1991) *Achieving Quality and Diversity: Universities in a Multicultural Society*. Macmillan Publishing Company, New York.
- Taylor, J A (1998). Self Test: a flexible self assessment package for distance and other learners. *Computers and Education* 31, 319-328.
- Taylor, J. C. (2001). *Fifth Generation Distance Education*, Keynote Address presented at the 20th ICDE World Conference, Düsseldorf, Germany, 1-5 April 2001. http://www.usq.edu.au/users/taylorj/publications_presentations/5thGenerationDE.doc
- Taylor, J.C. (1995). 'Distance education technologies: The fourth generation'. *Australian Journal of Educational Technology*, 11, 2, 1-7. <http://www.usq.edu.au/users/taylorj/readings/4thgen.htm>
- Taylor, J.C., Postle, G., Reushle, S. and McDonald, J. (2000). A research agenda for online education. *Indian Journal of Open Learning*, Vol 3, 1, 99-104, ISSN 0971-2690.
- Van Vuuren, P. and Bull, D. (1997). Information Technology Availability and Proficiency: Survey results for the Tertiary Preparation Program 1997. Office of Preparatory and Academic Support, University of Southern Queensland, Australia. 20 pp.